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White House Finally Finds a New Chief for NSF

After a long and often-frustrated search for a new Director for the National Science Foundation, the Reagan Administration has found its man right there at NSF headquarters. He's Edward A. Knapp, a 24-year member of the Los Alamos National Laboratory who arrived at NSF just last September to take the post of Assistant Director for Mathematical and Physical Sciences.

The appointment of a Los Alamos veteran to head the central bank for academic basic research was sure to arouse mutterings about that nuclear gung-ho establishment acquiring excessive influence in Washington science-policy affairs. And it did stir such comments. But though Knapp's selection as NSF Director was initiated in the office of another Los Alamos alumnus, Presidential Science Adviser George A. Keyworth, the fact is that the Administration turned to Knapp only after the incumbent Director, John B. Slaughter, had indicated his impatience to leave and several university scientists flatly turned down offers of the job.

Congress Brimming With Bills on R&D, Education—Page 3

The reasons for the rejections varied from case to case, but prominent among them is the government's frozen pay scales, which limit the Director's salary to $60,700, though the post is at a level that calls for $77,300. Slaughter cited personal financial burdens when he announced last June that he had accepted apointment as Chancellor of the College Park campus of the University of Maryland, where he will receive $75,000, an official residence, a car, and several other perks (SGR Vol. XII, No. 11).

But in addition to the salary limitations—which long ago became a major difficulty in hiring and retaining senior executives throughout the government—there's also the fact that the Reagan Administration hasn't treated the Foundation with the special tenderness that NSF's clientele have come to expect of presidents. Early in the Administration, budgets and programs were kicked around without even so much as prior notice to NSF's senior policymaking body, the National Science Board. Whereas the Foundation directorship formerly was one of the most prestigious positions in the federal science establishment, it has lost a good deal of luster under the Reagan Administration.

Knapp comes to the job with scientific credentials at least on a par with each of his six predecessors in the post since NSF came into being in 1951. Awarded a PhD in high-energy physics by UC Berkeley in 1958, he joined the Los Alamos National Laboratory that year and worked on controlled thermonuclear reactions. He later participated in the initial planning for the Laboratory's linear proton accelerator. In 1973, after a sabbatical at the European Organization for Nuclear Research (CERN), Knapp returned to Los Alamos and headed a program for adapting the linear accelerator for cancer treatment. In 1978, he organized and headed the Accelerator Technology Division, and held that post until he joined NSF. His official biography lists him as the author or co-author of nearly 100 scientific papers.

He thus has solid qualifications in research and administration, but what he does not have is the university employment background of all his recent predecessors, or membership in the National Academy of Sciences, which most, though not all, held at the time of their appointment. (On this latter point, a White House science aide caustically remarked to SGR that Knapp "would

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In Brief

NSF's latest analysis of the division of the federal R&D budget shows defense—that's the Pentagon, plus military functions of other agencies—up to 61 percent of the total in the current fiscal year, to a record $26.4 billion. (See Page 8 for federal R&D spending from 1973-83.)

The genital herpes panic has inspired NIH to be ready with the numbers when its political overseers inquire, as many have lately been doing, about the amount being spent to research the malady. The answer is that the budget, spread over three institutes, is about $6.5 million this year, compared with $6.1 million two years ago.

The trends seem to be running against hopes that foreign students will make up for the enrollment declines in American colleges and universities. According to the Institute of International Education, foreign enrollments this year grew only 6 percent, compared to an 8-16 percent annual growth over the previous six years. The tapering of growth was mainly caused by a sharp drop in Iranian enrollments, from 47,550 in 1981 to 35,860. Foreigners total about 2.6 percent of the US higher education enrollment of 12.4 million.

...No Takers Found in University Posts

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certainly be an Academy member if he didn't come from a government lab.)

In any case, the appointment has inspired a bit of that sniping with silencers in which the academic and scientific communities and their Congressional friends excel. A few days after the appointment was announced, an anonymous "congressional aide" was quoted in the *Chronicle of Higher Education* as saying that "the most significant point...is that he's not a university person. That's a break from tradition." Others speculated that Knapp's appointment might signify that the Administration has some significant policy changes in mind for the Foundation.

Perhaps it has, but the word given to SGR is that Slaughter was welcome to stay on for the four remaining years of his six-year appointment and that Knapp was pretty far down the line of candidates deemed desirable by the Administration.

That the Administration was out there seriously searching was confirmed to SGR by several sources, though presidential protocol calls for a recruitment minuet that predicates an offer on the assurance that it will be accepted. The closest thing to a leak occurred when Scripps Oceanography chief William A. Nierenberg, a perennial target of federal headhunters, entered a preemptive declination to thwart an oncoming bid, thus making it possible for all parties to say he never was offered the job.

Lewis Branscomb, the IBM Chief Scientist who chairs the National Science Board, credits the White House Science Office and Personnel Office with having done "a serious job" of trying to recruit several of the persons on a list of candidates prepared by a search panel of the Board. The panel was established at the request of Science Adviser Keyworth. "We created the best list we could," said Branscomb—who was appointed to the Board during the Carter Administration—"but they got a lot of turndowns."

Knapp, who was still at Los Alamos when the list was prepared, was not among the 30 names that the Board submitted to Keyworth. Prior to Knapp's appointment as an Assistant Director, Branscomb told SGR, he knew him only by professional reputation. Following Knapp's appointment as Director—a recess appointment while the Senate is not in session—Branscomb issued a friendly statement: "Dr. Knapp is an excellent physicist and has made a very favorable impression on all of us at the Foundation since he came earlier this year to be an Assistant Director. I look forward to working together

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NSF Directors Come and Go

An irony of the politics of the National Science Foundation is that the last four of its six directors voluntarily left before completing the statutory six-year term that NSF's founding fathers deemed essential to avert political intrusions on the agency.

In three of those four cases, they could easily have stayed on, but went off to big-league academic posts.

The founding Director, Alan T. Waterman, held the job for two terms, from 1951 to 1963. His successor, Leland Haworth, left in 1969, after serving out the full six-year term. After that, none stayed for the duration.

William McElroy came from a laboratory directorship at Johns Hopkins in 1969 and left in 1972 to become Chancellor of UC San Diego. His successor Guy Stever, from the presidency of Carnegie-Mellon University, was in his fifth year as NSF Director when President Gerald Ford asked him to become Director of the newly created White House Office of Science and Technology Policy—a request that couldn't be refused, given the fragile condition of the post-Watergate presidency.

Stever's successor at NSF, Richard Atkinson, a Stanford psychologist and administrator, held the directorship from 1977 to 1980, when he left to succeed McElroy at San Diego. He was succeeded by John B. Slaughter, who, after 18 months in the job, accepted the chancellorship of the University of Maryland at College Park.

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Editor and Publisher **Daniel S. Greenberg**
Associate Publisher **Wanda J. Reif**
Circulation Manager **Diane Kupelian**

Contributing Correspondents
Christopher Joyce, Kim A. McDonald (Washington); Francois Seguier (Paris); Ros Herman (London)

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A Congressional Wave of Interest in R&D

The Congressional post-election lame-duck session, starting November 29, will be so weighed down by a backlog of appropriations bills that there won't be time for serious attention to anything else. But a look at what's in the legislative hopper of the outgoing Congress shows that a boost for science, technology, and education is much on the minds of the members and is likely to receive close attention when the 98th Congress convenes in January.

Among the bills that have been introduced are the following, according to a summary prepared by the Congressional Research Service:

HR 5252, co-sponsored by Rep. Don Fuqua (D-Fla.), Chairman of the Science and Technology Committee, and Rep. Doug Walgren (D-Pa.), Chairman of the Science, Research, and Technology Subcommittee. The bill authorizes each federal agency and department to establish programs for training technical and engineering personnel in collaboration with state and local governments. It also establishes a Coordinating Council on Engineering and Scientific Manpower within the National Science Foundation to coordinate federal programs in science and engineering education. The bill was introduced last December and was the subject of hearings before the Science and Technology Subcommittee on Science, Research, and Technology in April.

HR 5540, introduced by Rep. James J. Blanchard, who was successful as the Democratic candidate for Governor in Michigan November 2. The bill would amend the Defense Production Act of 1950 to provide assistance to modernize industries related to defense and to train manpower for them. Introduced last February, the bill has been the subject of several hearings and has been reported out by the Committee on Banking, Finance, and Urban Affairs and the Committee on Education and Labor.

HR 6656, introduced June 22 by Rep. Larry J. Winn Jr. (R-Kan.), ranking minority member of the Science and Technology Committee. The bill would establish a program of Presidential teaching and research fellowships in mathematics and science and a pre-college science and mathematics in-service teaching program.

HR 6674, introduced June 23 by Rep. Carl D. Perkins (D-Ky.), Chairman of the Education and Labor Committee. The bill would establish a broad national program to improve the quality of education in mathematics, the sciences, and technology "to increase the productivity of the nation's economy and ensure an adequate number of high school graduates qualified to serve in the nation's defense..."

HR 6723, introduced June 24 by Rep. Ron Wyden (D-Ore.), a member of the Energy and Commerce Committee and the Small Business Committee. The bill would amend the Internal Revenue Code to expand tax credits for corporations that contract basic research to universities and other non-profit institutions, and would also increase incentives for donations of research equipment and other assistance to such recipients.

HR 6775, introduced July 23 by Rep. Dave McCurdy (D-Okla.), a member of the Armed Services and Science and Technology committees. The bill would provide low-cost educational loans to college students who seek mathematics and science degrees and who go on to pre-college math and science teaching.

S 2421, introduced April 22 by Senator John Glenn (D-Ohio). The bill would create a National Coordinating Council on Technical, Engineering, and Scientific Manpower.

S 2683, introduced June 23 by Senator Gary Hart (D-Colo.). The bill would establish a national program to "offer incentives to local educational agencies to improve the quality of instruction and levels of achievement in mathematics, sciences...and new technology."

S 2737, introduced July 15 by Senator Glenn. The bill would amend the Higher Education Act of 1965 to provide low-cost loans for college students preparing for pre-college teaching in math and science.

S 2809, introduced August 4 by Senator Harrison Schmitt (R-NM), The bill would establish within the White House Office of Science and Technology Policy a program to strengthen research capabilities in academic

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NSF DIRECTOR

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with Dr. Knapp to continue the National Science Foundation's fine traditions of scientific and engineering leadership."

Knapp's appointment was announced by the White House on November 2, the day after Slaughter left for College Park. Slaughter had publicly announced last June that he would leave "by January 15," a departure date sufficiently far off, he hoped, to give the Administration plenty of time to hire a successor. As the months went by and the selection process seemed to be motionless somewhere between the White House Science and Personnel offices, Slaughter was said to be getting a bit irritated by the delay. On October 19, he told SGR that he was too eager to move on to his new position, and would not be receptive if a request were made to delay his departure.

Meanwhile, a White House aide had a simple, non-ideological explanation for the delay: "Lots of things move very slowly here," he said.—DSG

Capitol Hill Science Lineup Little Changed

The election produced few changes in the Congressional ranks that deal with science and technology, but Democratic gains in the House and near misses for several Republicans in the Senate may mean that the Reagan reshaping of federal research policy has gone about as far as it can go.

The most prominent loser was ex-astronaut Senator Harrison Schmitt (R-NM), who chairs the Commerce, Science, and Transportation Subcommittee on Science, Technology, and Space, and the Appropriations Subcommittee on Labor, Health and Human Services, Education. Schmitt, who sought the impossible split image of a Reaganite fiscal tightwad who is sympathetic to the costly ambitions of the scientific community, never caught on as a conservative or a champion of research. He lost to the New Mexico's attorney general by a sizable margin, 217,191 to 186,014. It's too early to tell who will succeed him in the two subcommittee chairmanships, both influential posts that Schmitt never was able to turn into a base of power for himself in the Senate.

In the House, Margaret Heckler, of Massachusetts, the ranking Republican on the Science and Technology Subcommittee on Science, Research, and Technology, was defeated, as was Robert N. Shamansky (D-Ohio), a first-termer who was also on the S&T Committee.

Winning re-election after initial worries about a difficult time were Rep. George Brown (D-Calif.), who chairs the Agriculture Subcommittee on Department Operations, Research, and Foreign Agriculture, and Rep. Doug Walgren (D-Pa.), Chairman of the Science and Technology Subcommittee on Science, Research, and Technology.

With the election returns indicating a substantial distaste for Reagan's economic policies, and survey after survey showing high public esteem for science and education (see Page 5), the Reagan revolution in research policy and related areas may turn out to be short-lived.

The area that is ripest for a turnaround is science education, which Reagan purists would altogether chuck out as a federal responsibility. The pre-election House, however, forced an unsought $30 million on the National Science Foundation for the promotion of science-education programs; with an additional 26 seats at their command, it's a safe bet that House Democrats in the next Congress will be pushing for even more in that category.

As for biomedical-research money, it is doubtful that this holiest of research entities can be crimped much longer to satisfy the bookkeepers. The biomedical research community, under the orchestration of the Association of American Medical Colleges, is gearing up for a long-running, nationwide public relations campaign designed to drum up popular support for medical research (SGR Vol. XII, No.14). And the "disease-of-the-month" lobbies, inspired by Congressional receptiveness to setting up a separate Arthritis Institute at the National Institutes of Health, are mobilizing for their turn at getting the visibility that brings bigger budgets.

Finally, there's the eternal question of what to do about the national labs, many of which the Administration has quietly put on starvation rations while innumerable panels and committees leisurely study their fate. The labs and their friends set up a moderate din in Congressional hearings prior to the election, and found many members sympathetic but not certain what they could do in the face of the Administration's insistence that the labs had grown aimlessly. Indeed some of them have, but with science and technology increasingly venerated as the answer to economic decline, these vast research institutions suddenly have taken on new value for their regions. The new political climate does not favor continued shrinkage.

With a consensus developing that the Administration has gone too far in accelerating a defense buildup, the Pentagon's renewed role as a supporter of basic research is likely to be in for trouble. Compared to the standstill budgets that non-defense agencies have had to bear, DoD's boom in basic research funds is con-

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LEGISLATION

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institutions and to provide assistance for students in science, engineering, and technology.

These are just part of a large inventory of bills that range from window dressing resolutions of encouragement to major commitments of additional federal resources for teaching science and math and the conduct of research.

What's clear is that science, high-tech affairs and education have attracted serious political interest—witness the rise of the so-called Atari Democrats (with the exception, of course, of the most fervent of them, California's Jerry Brown, who didn't make it to the US Senate).

It isn't certain what formulations this interest will take in the new Congress, but the pressure is building to rejuvenate science and math education and to resume growth of the academic research enterprise. Given the message of the elections, it is not likely that the Reagan Administration will see any advantage in fighting against the Congressional impulse to be generous to the government agencies that support education and research.

Survey Finds Public Keen for Education, R&D

A recently published survey conducted last summer for 11 national education associations finds little harmony between the Reagan Administration and the general public on federal support of science, education, and various related activities. Nothing new in that, of course, but in view of the election returns and the enshrinement of polling of as the revelatory device for public policymaking, the survey, titled "American Attitudes Toward Higher Education," merits some attention.

Performed by Group Attitudes Corporation, a subsidiary of the Hill and Knowlton, Inc., public-relations firm, the survey results are based on 1188 "useable" replies from an original distribution of 4200 questionnaires—a pretty wide cast of the net, as such things go.

Among the questions and answers were the following:

Please indicate how strongly you favor continued federal support for the following higher education programs:

	Favor	Oppose	Undecided
Medicine	81.0%	6.1%	9.5%
Physical Science	64.0	12.7	19.2
Humanities	41.8	31.2	23.1
Social Sciences	39.0	31.9	25.2
Programs in the Arts	25.9	46.8	22.3

You are probably aware that the federal government is thinking about reducing budgets of a number of federally funded projects and programs. What would be your recommendations for these cutbacks?:

	Should Not Be Cut Back at All	Should Be Cut Back Only Somewhat	Should Be Cut Back Drastically
1. Medical care for the aged	68.0%	19.2%	9.5%
2. Cancer and Medical research	62.0	27.6	7.4
3. Energy research and development	43.1	40.4	13.4
4. Aid to higher education	42.2	38.3	15.0
5. School lunch program	33.5	44.0	18.4
6. Defense spending	32.5	42.0	22.3
7. Aid to agriculture	28.6	52.4	13.9
8. Social welfare programs	22.5	42.0	31.6
9. Space program	19.9	46.3	30.7

For additional information about "American Attitudes Toward Higher Education," contact Walter K. Lindenmann, President, Group Attitudes Corp., 420 Lexington Ave., New York, NY; tel. (212) 210-8840.

The sponsoring organizations are:

American Association of Collegiate Registrars and Admissions Officers

American Association of State Colleges and Universities

American Association of University Professors

American Council on Education

Association of American Colleges

Association of Governing Boards of Universities and Colleges

Council for Advancement and Support of Education

Council for Financial Aid to Education

Council of Independent Colleges

National Association of College and University Business Officers

National Association of Independent Colleges and Universities

The Poison Pen Department

We don't ordinarily take note of correspondence between the members of the electorate and Mr. Reagan, but an exception is inspired by an unusual missive that has come our way via a circuitous route. Dated July 14, 1982, with a return address from a Washington suburban residential area, and addressed to The President, The White House, it reads as follows:

"Your proclamation of the National Farm-City Week for 1981...was outstanding. The modern day miracle [of agricultural productivity] occurred primarily because of States' Agricultural Experiment Stations and Cooperative Extension Service, and Agricultural Research Service, US Department of Agriculture.

"*Science & Government Report* [Vol. XII, No. 10, 'White House Aims to Shake up Agricultural R&D'] indicates, in my opinion, that a relatively high level official of the White House is trying to destroy the above system.

"When this Administration keeps a political appointee from a previous Administration at a fairly high level in the Office of Science and Technology Policy, who in my opinion is trying to damage the above system, I refuse to make more political contributions!!

"However, if the above is corrected I will be happy to continue making contributions to your cause and to convince some others also to contribute.

Sincerely yours,
W.I. Thomas"

Enclosed was a check torn in three pieces. Inquiry reveals that W.I. Thomas is Dr. Walter I. Thomas, who holds the title of Administrator of the Cooperative State Research Service, US Department of Agriculture. In response to an inquiry, he told SGR that the letter has gone unanswered.

Scientific Fraud No Rarity, New Book Says

While the leaders of the scientific community overwhelmingly discount scientific fraud as rare, aberrational, and overblown by the press, it's none of those, according to a forthcoming book by two experienced journalists from eminently respectable publications. Titled Betrayers of the Truth, *and scheduled for publication January 10 by Simon and Schuster, the book was co-authored by William Broad, of the* Science Magazine *news and comment section, and Nicholas Wade, a* Science *alumnus who is a member of the* New York Times *editorial board. Leaning heavily on celebrated cases of fraud from long ago right up to the present, the book is bound to ruffle the mandarins of science and arouse wide public interest. Following are excerpts:*

•

The chances of getting caught in committing a scientific fraud are probably quite small. Replication in science is a philosophical construct, not an everyday reality. It may be used to prove fraud when fraud is suspected on other grounds, but is almost never the prime cause of suspicion. Most of the cases described here are instances of whole-cloth fraud that came to light through egregious arrogance or carelessness on the part of the forger. The researcher who takes a modicum of care in committing a minor fraud is almost guaranteed immunity if the "self-policing mechanisms" of science are all he has to fear.

The rewards for cheating, on the other hand, may be quite substantial. Science works on results. A good result has a better chance than a mediocre result of being published, of helping to secure the next research grant, of winning promotion, tenure, prestige, and prizes. With high rewards, and low chances of apprehension, we would expect minor fraud to be quite commonplace.

Most of the cases described here involve major fraud, by which we mean the reporting of an experiment that did not take place. Minor fraud occurs when the experimenter selects or distorts the data from real experiments so as to make them appear smoother or more convincing. We would expect that for every case of major fraud that comes to light, a hundred or so go undetected. For each major fraud, perhaps a thousand minor fakeries are perpetrated. The reader can supply his own multiplication factors; ours would indicate that every major case of fraud that becomes public is the representative of some 100,000 others, major and minor combined, that lie concealed in the marshy wastes of the scientific literature.

The exact frequency of fraud in science is less important than the fact that it occurs, and at a far from negligible rate. The looseness of the self-policing systems of science. . .allows fraud to flourish. The reward system and career structure of contemporary science are among the factors that create the inducement to fraud. That is why the self-serving manipulation of data is endemic to modern science. The roots of fraud lie in the barrel, not in the bad apples that occasionally roll into public view.

Science a "Celebrity System"

Science may in one sense be a community, but in another, equally important, it is a celebrity system. The social organization of science is designed to foster the production of an elite in which prestige comes not just on the merits of work but also because of position in the scientific hierarchy. Members of the scientific elite control the reward system of science and, through the peer review system, have a major voice in the allocation of scientific resources. . . .Those whose efforts are exploited go along with the practice because they see it as an unchangeable part of the system, from which they too hope to profit in their turn.

The lab-chief system encourages not only careerism but also cynicism because, by its structure and organization, it tends to force a disjunction between the scientist's two goals, the pursuit of truth and the desire for credit. The system, with its heavy emphasis on results, on producing papers, on winning the next research grant, sets up pressures that favor glory-getting and credit-grabbing over the dispassionate pursuit of truth.

Science to a large extent is hard and discouraging work. For every second of cognitive exaltation at a pretty idea or an experiment that finally works, the researcher must put in hours of frustrating labor at the laboratory bench, trying to master a new technique, to iron out the bugs, to wrest a clear answer from the con-

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ELECTION

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spicuous and inviting. Budgeted for $828 million this fiscal year—an increase of $218 million since 1981—the Defense bundle for basic research is only $150 million behind that of the National Science Foundation's. NSF's friends on Capitol Hill have welcomed Defense support of university-based science as relief for the Foundation's strained budget. But they have also looked with dismay on the Reagan Administration's preference for funneling growth through the Pentagon, rather than resuming real growth for NSF, which, after all, is by statute the chosen instrument of the US government for supporting academic science.

...Role of Replication is Exaggerated

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fusing substance of nature. To persevere in research requires a high degree of motivation, for which glory is often the incentive, denial of grant money the goad. But that motivation can easily turn to cynicism if younger researchers see that their elders are more preoccupied with chasing scientific honors than in dispassionate examination of nature.

Fraud is revealing not only of the sociological structure of science but also of scientific methodology. Fraud and self-deception generate incorrect data that post a challenge to the self-corrective mechanisms of science, in particular to the verification of scientific results. As is shown by many of the frauds discussed here, the replication of an experiment is often undertaken only as a last resort, and usually to confirm suspicions arrived at for other reasons. Exact replication is not a regular part of the scientific process. The reason is simple: there is no credit to be gained from replicating someone else's experiment.

Replication is not the engine of scientific progress. A closer description of the central validation method of science would be to say that recipes that work are adopted into the general cuisine. Science is in some respects a profoundly pragmatic enterprise. Theory may get the attention but the working scientist depends on his ability to make experiments work. If a new experiment or technique is successful, it will be adapted by other scientists to their own ends. It is by a continuous succession of small improvements on existing recipes that the scientific juggernaut inches forward. Only rarely are bad recipes demonstrated to be the product not of chefs but of charlatans. More often they just fall by the wayside, to be ignored along with a great mass of other forgetable, insignificant, or somehow erroneous research.

Incentives for Fraud

By and large, those features in the social organization of science that encourage and reward careerism also create the incentive for fraud. The excesses of the careerist system spread cynicism among young researchers, who sometimes respond to pressure by imitating the worse aspects of their elders' behavior. This is the atmosphere in which the finagling of data or the wholesale invention of results is perhaps most likely to occur. Scientists should be more skeptical of elitism, and particularly of young superstars in elite institutions who seem to do too much too fast. A branch of knowledge that claims to be universal should ensure that its own internal tests are evenly applied.

A simple but valuable reform would be for the scientific community to set itself more formal guidelines for the assignation of credit, in particular for that critically important part of a scientific paper—the authorship line. Two principles might be established. First, all people named as authors should have made a definably major contribution to the work reported. Any minor contribution should be explicitly acknowledged in the text of the article. Second, all authors of a paper should be prepared to take responsibility for its contents in precisely the same measure as they stand to take credit.

Lab Chiefs Hog Credit

Such steps, if generally accepted, would curtail the inherently dishonest practice of lab chiefs signing their name to work in which they have been only peripherally involved, if at all. It would also spare the public the ludicrous spectacle of lab chiefs who hog credit for everything that goes well but disclaim responsibility when fraud is discovered. If a lab chief is not close enough to a research project to know whether data is being falsified, he should not put his name on the paper. For the papers he does sign, he should take full responsibility. To most nonscientists, such principles probably seem too obvious to be worth stating.

Just as the emphasis in publication should be shifted from quantity to quality, so promotions and grant renewals should not be handed out on the basis of a long list of seemingly important publications. Administrators should develop sophisticated means of reading and evaluating a research record, such as citation analysis, where the influence of a scientist can be measured by the number of times his work is cited by other researchers. Such techniques tell much more about the real worth of a scientist than a long list of publications on a curriculum vitae.

Too Many Scientists?

A reduction in the number of scientific articles of course suggests a more radical kind of surgery, that of a reduction in the number of scientists. The available evidence indicates that the great majority of research responsible for the advance of science is produced by a small number of scientists. This small elite depends overwhelmingly on the research of other members of the elite, not on that of the wider majority. The pace of scientific advance would not obviously be slowed if this majority did not exist. It might even be enhanced if pursued by a leaner and fitter community of researchers. Perhaps there are too many scientists. Perhaps basic scientific research would be more appropriately supported by private patrons, as economist Milton Friedman has suggested, instead of by the government.

Functional Outlays in Federal R&D—1973-83

Function	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982 estimate	1983 estimate
Total	$16,800	$17,410	$19,039	$20,780	$23,983	$26,516	$29,041	$31,623	$35,547	$38,701	$43,174
National defense	9,002	9,016	9,679	10,430	11,864	12,899	13,791	14,946	18,413	22,025	26,437
Space research and technology	2,824	2,702	2,764	3,130	3,365	3,481	3,969	4,457	4,924	5,390	6,047
Health	1,585	2,069	2,170	2,351	2,629	2,968	3,401	3,694	3,871	3,864	4,013
Energy	630	759	1,363	1,649	2,562	3,134	3,461	3,603	3,501	2,889	2,034
General science	658	749	813	858	974	1,050	1,119	1,233	1,340	1,387	1,509
Transportation	572	693	635	631	708	768	798	888	869	748	831
Natural resources and environment	554	516	624	683	753	904	1,010	999	1,061	952	819
Agriculture	308	313	342	383	457	501	552	585	659	694	740
International affairs	28	24	29	42	66	57	117	127	160	164	194
Education, training, employment and social services	290	236	239	255	230	345	354	468	298	200	189
Veterans benefits and services	74	85	95	98	107	111	123	126	143	131	140
Commerce and housing credit	50	51	65	69	71	77	93	102	106	107	92
Community and regional development	78	82	93	109	101	92	127	119	104	63	45
Income security	106	71	72	48	55	67	57	77	43	35	41
Administration of justice	33	35	44	35	30	44	47	45	35	28	24
General government	7	9	12	12	13	20	23	22	22	23	22

Listed in descending order of budget authority. Data for 1973-77 are shown in obligations; data for 1978-83 are shown in budget authority. Data for 1982 and 1983 are estimates as shown in the 1983 budget published in February 1982.

SOURCE: National Science Foundation

Though Congress still has to complete action on 13 major appropriations bills—including bills for virtually all federal research agencies except the National Science Foundation—the general shape of the R&D spending for the current fiscal year is not likely to depart significantly from the budget that the President submitted in February, as reflected in the final column of the above table, just published by NSF. (The table is taken from a newly published report, NSF 82-322, six pages, available without charge from Division of Science Resources Studies, National Science Foundation, Washington, DC 20550.)

Science & Government Report
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